



moneo|LifetimeEstimator

Intelligent prediction of remaining useful lifetime of components subjected to cyclical wear.



Introduction

The ongoing digitalisation of industries poses challenges for companies in monitoring and controlling their production processes.

One of the significant difficulties is the reliable monitoring of critical process parameters such as temperature, flow and vibration. In modern production plants, enormous amounts of sensor data are continuously generated through manual monitoring, which is not only time-consuming but also highly error-prone. Early detection of anomalies and undesirable process changes is crucial, as unplanned machine downtime can lead to massive financial losses.

Recent studies show that the world's 500 largest companies lose around 1.4 billion dollars a year due to unplanned downtime, which equates to 11% of their total revenue. In heavy industries, the cost per hour of downtime is around 59 million dollars - 1.6 times higher than in 2019¹.

Added to this is the increasing shortage of specialised maintenance personnel. Companies encounter the challenge of implementing complex monitoring systems that work reliably and can also be operated by less specialised employees. The loss of expert knowledge due to staff turnover also makes it necessary to use systems that can automatically recognise and evaluate anomalies without relying on years of experience.

These complex challenges require innovative solutions that are both technologically mature and user-friendly. In addition, it can also be smoothly integrated into existing production environments.

The moneo[LifetimeEstimator is an intelligent tool that makes it possible to forecast the remaining lifetimes of critical process components and materials - without expert knowledge or programming skills. The system regularly monitors the current wear or consumption value and uses AI methods to calculate future developments.

¹ The true cost of downtime 2024: a comprehensive analysis, AEMT 2024
<https://www.theaemt.com/resource/the-true-cost-of-downtime-2024-a-comprehensive-analysis.html>

Your solution: moneo|LifetimeEstimator

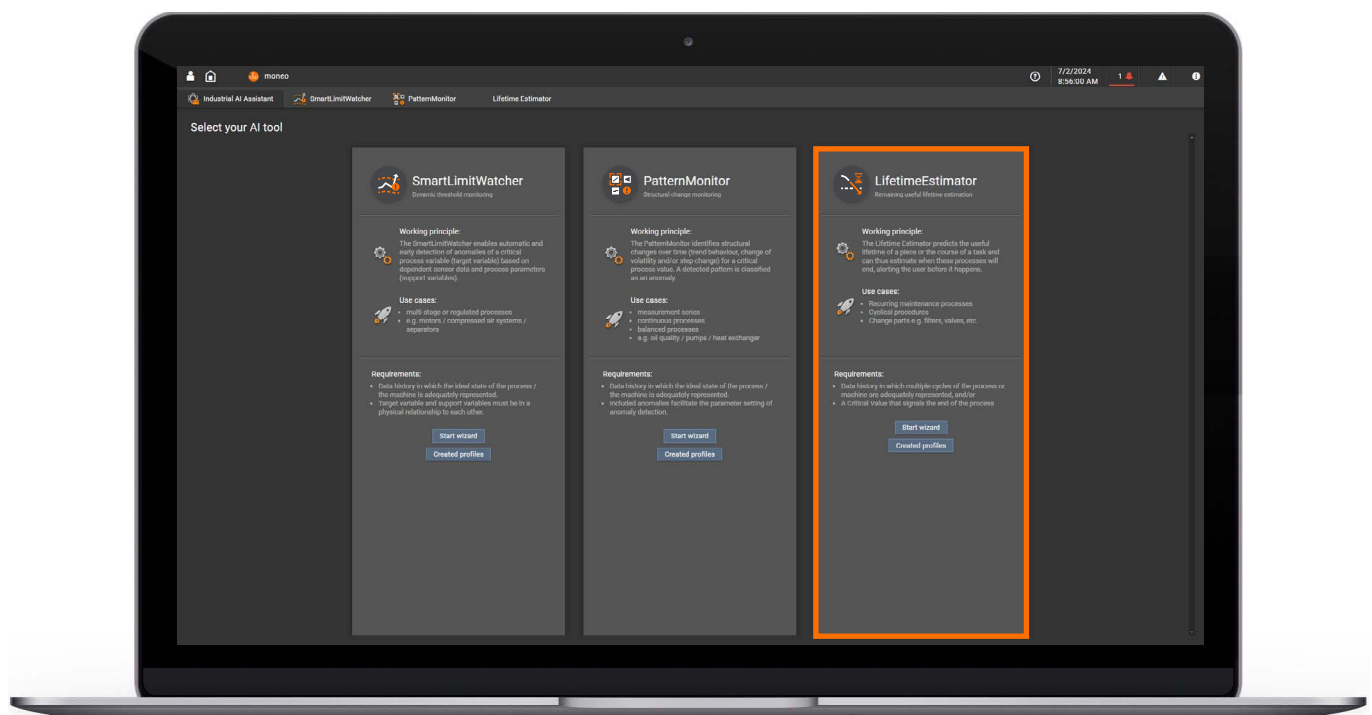
The moneo|LifetimeEstimator is a pioneering solution in the field of predictive maintenance. It was developed as an intelligent assistance system for predicting the remaining lifetime of components subject to cyclical wear.

The system uses a combination of different AI algorithms that make it possible to create an individual 'fingerprint' of the wear behaviour from historical cycles of material abrasion and derive reliable forecasts for the remaining lifetime. The current condition, which describes the abrasion or consumption, is continuously monitored and AI methods calculate the future development.

Particularly noteworthy is the no-code approach, which enables users without data science knowledge to implement and control reliable predictive systems for their maintenance. The technology is based on advanced AI methods and continuously analyses abrasion behaviour in order to determine the optimum maintenance time at an early stage.

Thanks to the intuitive user interface and the integrated 5-step wizard, users can commission the system quickly and easily without having to deal with complex programming or data analysis. The scalability of the system enables the monitoring of a wide range of wear components - from filters to seals. Self-learning algorithms automatically adapt to different usage intensities and ensure continuous 24/7 monitoring without manual interaction.

The intelligent calculation of dynamic expectation ranges (confidence bands) for the abrasion indicator achieves a high level of reliability in the lifetime forecast. The flexible architecture of the system also allows integration into existing maintenance strategies. It can be easily expanded with additional components, so that companies can gradually expand their predictive maintenance.



Prediction of remaining lifetime

Knowing the remaining lifetime of cyclically abrasive components at an early stage is of crucial importance for industrial production. Abrasion parts such as filters or seals are subject to constant stress and wear out over time. If this abrasion is not recognised in good time, unexpected failures can interrupt production, leading to high costs and considerable efficiency losses. Predicting the remaining lifetime of such components enables precise planning of maintenance intervals and ensures that components are replaced when necessary. This reduces both the frequency of unnecessary maintenance and the risk of unplanned downtime. As a result, production processes can be organised more efficiently and resources are better utilised, which ultimately reduces the life cycle costs of a system.

The moneo|LifetimeEstimator offers an innovative solution here: it enables the automatic prediction of the remaining lifetime of cyclically wearing components. Using AI methods, the software analyses the historical wear behaviour and calculates the remaining lifetime until a critical value is reached.

The moneo|LifetimeEstimator differentiates between two main use cases:

Change cycles:

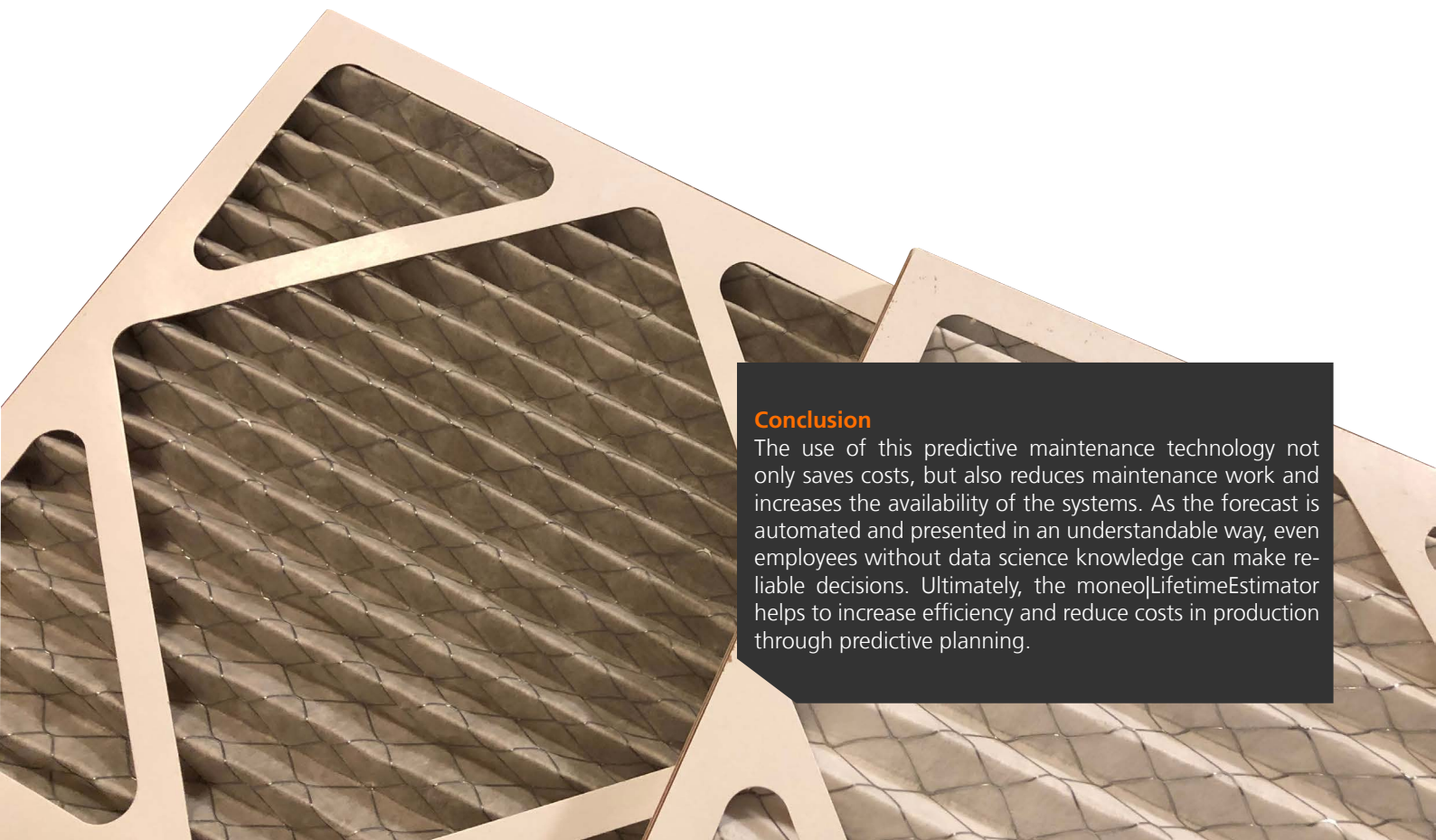
In this case, the moneo|LifetimeEstimator uses detailed AI-based forecasts and automatically adjusts the model. This ensures high prediction accuracy, supported by dynamic confidence intervals that reflect the expected range for the abrasion value. This allows the system to precisely determine when a component actually needs to be replaced, reducing unnecessary maintenance and minimising the risk of unplanned downtime.

Less than two cycles:

The moneo|LifetimeEstimator uses statistical extrapolation for new components or components that change rarely and for which less historical data is available. This provides an initial estimate of the remaining lifetime and forms the basis for subsequent AI-supported models. By adding new data, the forecast is continuously improved so that the moneo|LifetimeEstimator can make increasingly precise statements over time.

Conclusion

The use of this predictive maintenance technology not only saves costs, but also reduces maintenance work and increases the availability of the systems. As the forecast is automated and presented in an understandable way, even employees without data science knowledge can make reliable decisions. Ultimately, the moneo|LifetimeEstimator helps to increase efficiency and reduce costs in production through predictive planning.



Use Case: Prediction of filter abrasion

A classic area of application for the moneo|LifetimeEstimator is the prediction of filter abrasion. Filters are often monitored using the differential pressure wear indicator and replaced as soon as this value exceeds a certain limit.

As filters are regularly replaced or cleaned according to the manufacturer's instructions, the full potential of the component is often not utilised. Furthermore, human labour is expended that could be used for other more critical processes. In addition, this labour is exposed to risks such as particulate matter, which creates health risks in the event of excessive exposure.

Description

In an extraction system, the filter is installed at the outlet. The status is measured by two pressure sensors, one before and one after the filter. The differential pressure is calculated and monitored. The higher this differential pressure, the more blocked the filter is.

Showing the data used

To check how the filter behaves, whether it is a suitable application for the moneo|LifetimeEstimator or observing the data quantity, it is advisable to visualise the wear indicator in the moneo analysis in advance.

It can be recognised that there is an exponential progression of the measured value, which indicates blocking. The phases of system operation (2) and the changeover times (1) from used to fresh filters can also be recognised.



Cost savings

Condition-orientated filter change without the need for human resources to check the condition.



Operating conditions

Compliance with filter operating conditions through condition-based filter changes and minimisation of damage to the system.



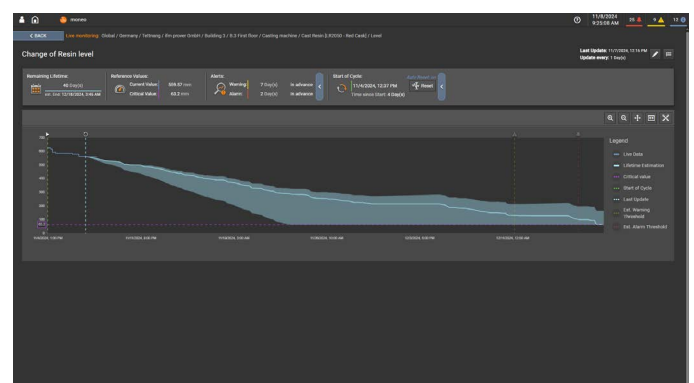
Air quality

Ensure that the air in the workplace is maintained and that vapours and dust are properly extracted.



Energy consumption

Avoidance of increased energy consumption when filters are too dirty. The performance of the system can be optimally utilised.



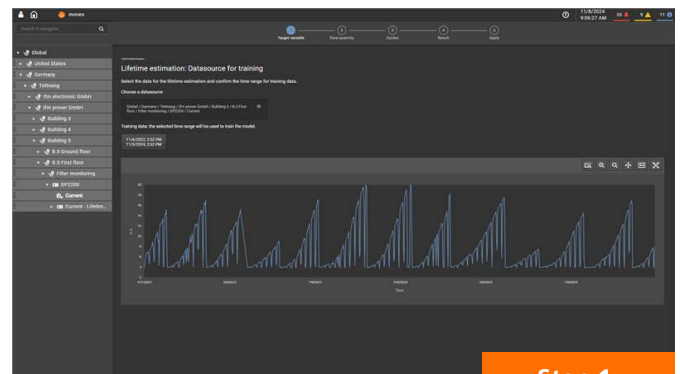
The 5-Step Wizard of the moneo|LifetimeEstimator

The moneo|LifetimeEstimator features an intuitive 5-step wizard that guides users, even those without data science expertise, through the configuration process.

Step 1: Select Data Source

In this first step, the abrasion variable to be monitored (target variable) is selected via drag-and-drop.

Additionally, the training period is defined, which should ideally include as many representative abrasion cycles as possible. The system supports both use cases with multiple historical cycles and scenarios with limited data points.

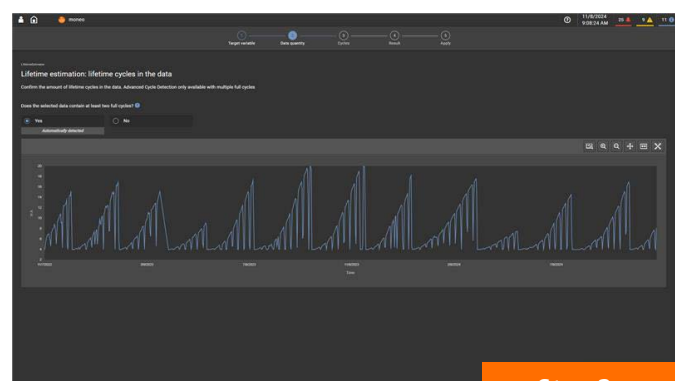


Step 1:

Step 2: Check Data Quality

The system automatically analyzes the available data and verifies whether sufficient cycles are present for AI-based training. Two use cases are distinguished:

- more than two cycles: Enables detailed AI-based predictions
- less than two cycles: Utilizes statistical methods for initial predictions



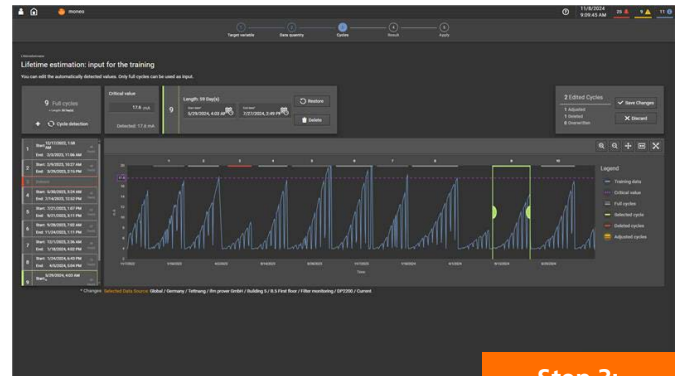
Step 2:

Step 3: Analyze Cycles

In this step, the detected abrasion cycles are visualized and can be adjusted if necessary. The system displays key information such as:

- the number of detected cycles
- average cycle length
- automatically detected critical value (threshold value)

Using an interactive interface, cycles can be added, edited, or removed.



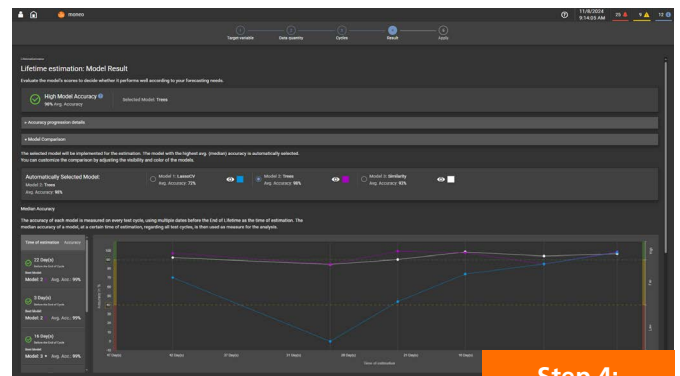
Step 3:

Step 4: Evaluate Model Quality

After training, the system provides detailed information on model quality:

- prediction accuracy
- reliability of forecasts
- comparison of different model variants
- forecast quality for various time horizons

Model accuracy is categorized into high, fair and low.



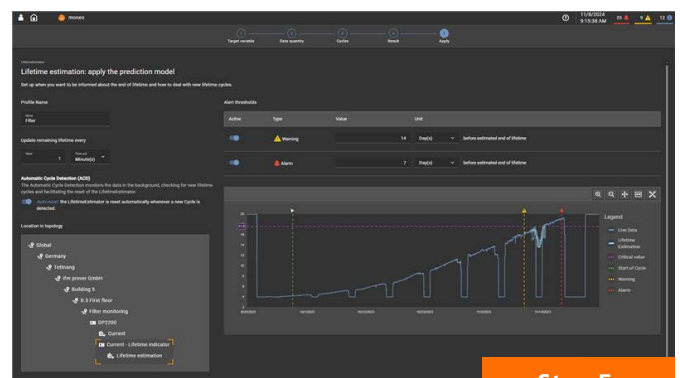
Step 4:

Step 5: Configure Monitoring

In the final step, parameters for ongoing monitoring are defined:

- profile name and position in the topology tree
- forecast update interval
- automatic cycle detection
- warning and alarm thresholds
- visualization options

Once the configuration is complete, continuous monitoring automatically starts in the background.



Step 5:

Live monitoring of the moneo|LifetimeEstimator

With the live view, you gain detailed insights into the current and predicted wear behavior of your monitored components. The clear and user-friendly interface presents all essential information at a glance.

In the upper section, you can see the key parameters for your decision-making process:

- the current remaining lifetime of the component
- the current abrasion value compared to the critical threshold
- the configured times for warnings and alarms
- the cycle start with the option for manual adjustment via a reset function

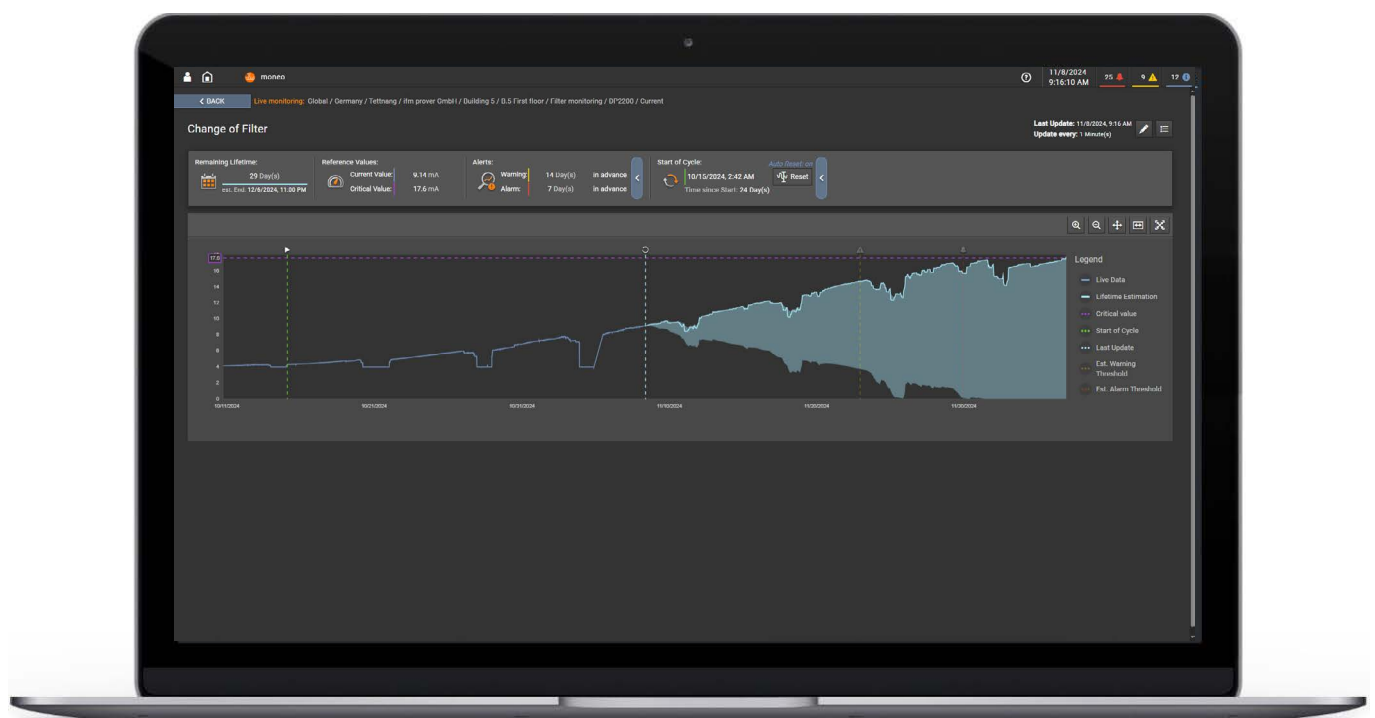
The central diagram visualizes for you:

- the current abrasion progression
- the calculated forecast with a confidence interval
- historical cycles as a reference
- the warning and alarm thresholds set by you

Through the function blocks in the upper right section, you can make adjustments at any time:

- change the profile name
- configure the warning and alarm thresholds
- set the update rate for the remaining lifetime calculation
- enable or disable automatic cycle detection

The live view allows you to quickly respond to changes in wear behavior and adjust the monitoring parameters if necessary. With the continuous updating of forecasts, the system optimally supports you in the predictive maintenance of your equipment.



Further tools of the moneo|Industrial AI Assistant

The moneo|Industrial AI Assistant is an integral part of the moneo|IIoT Insights software add-on and therefore also of the moneo|IIoT Core. The Industrial AI Assistant currently includes the AI software solutions moneo|SmartLimitWatcher, moneo|PatternMonitor and moneo|LifetimeEstimator, which are used for anomaly detection and in the field of predictive maintenance.

			
Features	moneo SmartLimitWatcher	moneo PatternMonitor	moneo LifetimeEstimator
Anomaly detection	✓	✓	X
Predictive analysis	X	X	✓
Usage of one measured value	X	✓	✓
Usage of several measured values	✓	X	X
Pattern identification	X	✓	X
Dynamic alarm and warning thresholds	✓	X	X
Prediction of the remaining useful life	X	X	✓
AI/ML technology	✓	✓	✓

